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Dietary fish oil, at intakes achievable in the human diet, reduces resting heart rate and ischaemia-induced cardiac arrhythmias in Sprague-Dawley rats

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Abstract

High intakes of dietary fish oil increase myocardial membrane incorporation of the long chain omega-3 polyunsaturated fatty acid (n-3 PUFA) docosahexaenoic acid (DHA; 22:6n-3) and of physiological consequence, heart rate is slowed and cardiac arrhythmia's are reduced.(1,2,3) Myocardial muscle membrane composition is also responsive to very small dietary fish oil intakes,(1) equivalent to what could be achieved in the human dietary intake range through regular consumption of fish.

Keywords

diet, reduces, resting, heart, rate, ischaemia, induced, cardiac, arrhythmias, sprague, dawley, rats, fish, dietary, oil, intakes, achievable, human

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Dietary fish oil, at intakes achievable in the human diet, reduces resting heart rate and ischaemia-induced cardiac arrhythmia's in Sprague-Dawley rats.

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Background:

High intakes of dietary fish oil increase myocardial membrane incorporation of the long chain omega-3 polyunsaturated fatty acid (n-3 PUFA) docosahexaenoic acid (DHA; 22:6n-3) and of physiological consequence, heart rate is slowed and cardiac arrhythmia's are reduced.[1,2,3]

Myocardial muscle membrane composition is also responsive to very small dietary fish oil intakes,[1] equivalent to what could be achieved in the human dietary intake range through regular consumption of fish.

Objective:

To test whether dietary achievable fish oil doses, relevant to human nutrition, can also provide protection against ischaemia-induced cardiac arrhythmia's during *in vivo* physiological conditions in the rat.

Methods:

Male Sprague-Dawley rats were fed isoenergetic diets (*ad libitum 4 weeks*) containing 10% fat by weight (22% energy). The control diet contained a blend of beef tallow (5.5%), n-6PUFA sunflower seed oil (2.5%) and 2% olive oil. In the fish oil (FO) diets, High DHA Tuna FO (NuMega Lipids) was exchanged for olive oil to provide 0.3% (FO1 – Low Dose) and 1.25% (FO2 – Moderate Dose) diets. Anaesthetised rats were artificially ventilated and subjected to *in vivo* regional ischaemia by coronary artery occlusion for 15 minutes while cardiovascular measures were collected. Heart tissues was harvested following experiments and used to assess myocardial membrane phospholipid fatty acid relative composition via gas chromatography with comparison to known standards.

Table 1: Equivalence of the diets used in this project

Rat Diet (Group) Fish Oil % weigh of total diet	Human* EPA+DHA per/day (g)	Human† Serve (100g) salmon/week	Human‡ Fish Oil Capsule/day
(Con) 0	0	0	0
(FO1) 0.31	0.57	2	1.7
(FO2) 1.25	2.3	8	6.8

***Based on human energy intake of 8700 kJ per day, †Based on salmon n-3 content of 1.9g/100g, ‡Based on typical fish oil capsule content of 330mg EPA+DHA.[1]**

Results: (Figure 1)

Myocardial fatty acid membrane relative composition showed significantly ($p<0.001$) increased DHA incorporation following FO supplementation in a dose related manner. Additionally the n-6 PUFA Arachidonic acid (AA) and Linoleic acid (LA) were significantly ($p<0.05$) reduced following supplementation.

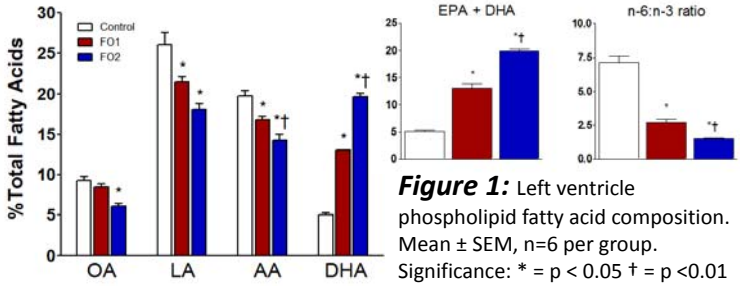

Figure 1: Left ventricle phospholipid fatty acid composition. Mean ± SEM, n=6 per group. Significance: * = $p < 0.05$ † = $p <0.01$ (One-way ANOVA)

Results: (Figure 2)

Resting heart rate of fish oil supplemented rats following anesthesia and prior to the ischaemic/reperfusion protocol being complete was significantly ($p<0.05$) reduced in a dose related manner.

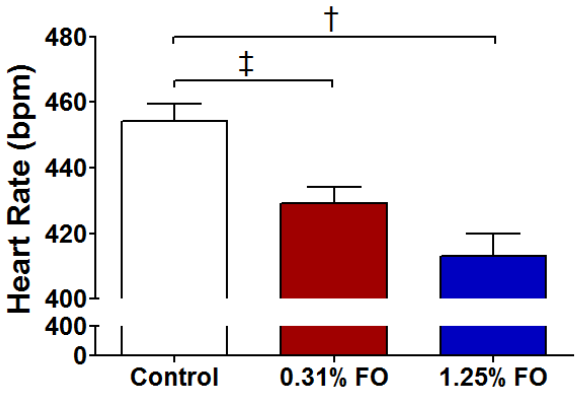

Figure 2: Resting heart rate of animals prior to I/R protocol. Mean ± SEM, n=18 per group. Significance: ‡ = $p < 0.02$ † = $p <0.01$ (ANOVA, Dunnett T test vs Control)

Results: (Figure 3)

Ischaemia-induced cardiac arrhythmia's were significantly ($p<0.05$) reduced in the moderate fish oil (1.25%) supplemented rats compared to control rats. This was shown via a reduction in the total incidence of ventricular fibrillation (VF); duration of VF and ventricular tachycardia; total fatal VF incidence; arrhythmia score and an increased time in normal sinus rhythm of rats supplemented with 1.25% fish oil.

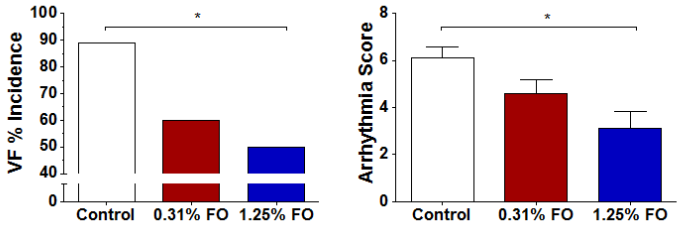

Figure 3: VF incidence and arrhythmia score of animals during occlusion of the left anterior descending coronary artery. Significance: * = $p < 0.05$ (One-way ANOVA)

Conclusions:

A human dietary or supplementation equivalent intake of fish oil increased the relative membrane composition incorporation of DHA in the left ventricle via replacing AA and LA in a dose response manner.

The increased incorporation of DHA into the left ventricle, slowed the heart and protected against serious ischaemia-induced cardiac arrhythmias, replicating previous findings of studies which used much higher doses not in the human dietary range.[3]

This study, for the first time, completed a physiological investigation of fish oils actions on the heart in an animal model which was focussed on clinically relevant nutritional intakes of DHA-rich fish oil. The results demonstrate the importance of addressing DHA dietary deficiency's for cardiac health and disease prevention.

Conflict of interest: none declared.

References

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